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Kinetics of the Phase Transformation of Olivine to Wadsleyite: a Comparison Study Between Natural Fe-bearing Olivine and Synthetic Forsterite

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Introduction: Understanding kinetics of the phase transformation of olivine to its high-pressure polymorphs is critical to modeling the extent of metastable olivine in subducting slabs. Previously we have obtained the growth rates of wadsleyite during the phase transformation at various pressure and temperature in natural San Carlos olivine (Fe-bearing). They are significantly lower than those obtained by other workers for forsterite at similar conditions. It is important to investigate the discrepancy because olivine is Fe-bearing in subducting slabs.

Methods and Materials: The starting materials are San Carlos olivine and synthetic forsterite. The powdered samples were dried in a vacuum oven at 160ºC for several hours prior to sample loading. Powdered NaCl (mixed with BN) was used as the pressure standard. The sample assembly was compressed to about 12 GPa at room temperature using the 250-ton LVP coupled with a T-Cup device and then annealed in the stability field of olivine at 1200ºC for 180 minutes. Following hot pressing, temperature was decreased to 550ºC and kept constant while pressure was increased to the target value. Temperature was then increased again rapidly to 1000ºC. Time-resolved x-ray diffraction patterns were collected every 2 to 5 minutes for both samples while the sample assembly remained under the constant *P*, *T* conditions. The pressure was calculated based on the Decker's EOS of NaCl and the temperature was measured by a W-3%Re/W-25%Re thermocouple.

Results: There is a profound difference in kinetics of the phase transformation of olivine to wadsleyite in two samples. The result is somewhat counter-intuitive. We observed complete transformation of forsterite to wadsleyite within the experiment duration. However, within the same duration, there is little transition in San Carlos olivine sample. This work demonstrates that rates obtained on analog materials (i.e., forsterite) can not be directly applied to natural olivine system. The discrepancy is due to slower rates of annealing out defects in forsterite sample during hot-press stage when compared to Fe-bearing sample.

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